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ATTACHMENT TO REVIEW OF RETENTION AND PERSISTENCE STUDIES FOR THE CALIFORNIA PUBLIC UTILITIES COMMISSION (CPUC)

ATTACHMENT G – ASSESSMENT OF TECHNICAL DEGRADATION FACTOR (TDF) STUDY

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ORGANIZATION OF THE REPORT

G ASSESSMENT OF TECHNICAL DEGRADATION FACTOR (TDF) STUDY

1.1 Executive Summary

This assessment is submitted as Attachment G of "The Review of Retention and Persistence Studies for the California Public Utilities Commission (CPUC)", submitted to the CPUC on June 30, 2004. In addition to the extensive review of 94 retention and persistence studies detailed in the main body of the June 2004 report, the CPUC requested a follow-on quick, small scale analysis of technical degradation factor analyses that were filed by PG&E. Five documents were reviewed for this assessment of the technical degradation factor (TDF) analyses. A sixth document was referenced by other documents, but the report was not available on the web sites, nor was its review requested by the CPUC.[1] The five documents (see Section 1.3**),** referred to as a group in the remainder of this report as "the Proctor TDF study", covered a number of measures. About half the measures were addressed in the first document, and the other half in the second document. The third document addressed follow-up work for two measures, and the fourth addressed those measures with a likelihood of exhibiting negative TDF values.[2]

Similar to the detailed report on retention and persistence studies, the objective of this review was to assess quality and consistency of the research and analysis work conducted in the five-volume TDF study. Key steps in the quality assessment are described in the methodology section.

Assessment of Quality of Proctor TDF Study

Overall, we conclude that the- Proctor TDF study provides a technically sound basis for estimating relative technical degradation factors for a wide range of efficiency measures. However, note that the Proctor TDF study that was reviewed did not involve collecting new, primary or in-field / in-situ data for most measures, but focused on: 1) conducting an exhaustive search of existing information from published and unpublished sources and in some cases from interviews, and 2) synthesizing the information into an engineering analysis of technical degradation rates. Where measures showed uncertainties, research plans were developed and additional (primary or secondary) research was undertaken. Our assessment includes a review of these additional research studies.

We found that the analyses of most measures were thorough where available data and information permitted. In several cases where degradation could be linked to specific components of efficient and baseline measures, the study explored the details of the

1 This assignment constitutes a follow-on task order to the initial work scope, requested of SERA in August, 2004.
2 Those with a TDF >1; Proctor refers to them as "negative".

components and potential degradation mechanisms. In general, original analyses that were conducted based on the existing information were technically competent. In several cases where further analysis was recommended, follow-up analysis was conducted. After initially recording the technical degradation factor as 1.0 for measures that exhibited likely increases in relative energy savings over time, the authors conducted follow-up analyses to quantify such negative relative technical degradation factors for four measures.[3]

The results showed:

- There are credible estimates of relative degradation factors for some efficiency measures, but not all measures have been examined.
- In most cases, relative degradation is the same for standard and efficient measures, so savings do not change relative to each other over time for most measures.
- Factors for some measures indicate savings would increase over time relative to those from standard measures, while others show savings would be likely to decline.

Our review of the Proctor TDF research resulted in low scores for the research associated with several specific measures indicating more work would be needed to provide confidence in the results. There are three measures for which the analysis received a score of 3.0, which we believe implies that the measures need further investigation before a specific TDF different from a default of 1.0 can be assigned for the purposes of earnings claims.

- Measure 3 – Oversized Evaporative Cooler Condenser (ECC): Estimated TDF ratio=0.85 over life of measure (from Column G, Table G.3). Claims using this TDF will be lower than using a default TDF value of 1.0.
- Measure 20 – Agricultural Pump Repair or Replacement: TDF ratio over measure lifetime=1.004. Claims using this TDF will be higher than using a default TDF value of 1.0.
- Measure 24 – High Efficiency Compressed Air Distribution System: TDF ratio over measure lifetime=1.0. This TDF estimate was the same as the default, but at this point was not well demonstrated. To date, this will have no effect on previous claims.[4]

Note that our assessment and scoring took into account the terms under which the study was conducted – a study with a limited budget focused on "available" or secondary data. Thus, a 5.0 indicates the analysis was well-done considering these scope limitations. Were we to evaluate a report in the context of a more comprehensive scope, we would have reserved a score of 5.0 for those conducting primary research.

Computation of Potential Dollars at Risk from Previous Claims

A key step in identifying claim dollars at risk was identifying those TDF values that had low quality scores in our assessment of the Proctor study, and for which the TDF values were different from the default value of 1.0. Table G.3 shows those measures with the potential to affect earnings claims. Column G computes the sum of the Proctor TDF factor annually over the measure's estimated useful life (EUL)[5] divided by the sum of a TDF value of 1.0 over the measure's EUL. A value of less than 1.0 indicates that the energy efficient measure's performance, and associated energy savings, degrades faster than for the non-energy efficient version of the measure (and those greater than 1.0 retain their performance characteristics

[3] By definition in the Proctor study, negative factors have a value greater than 1.0.

[4] However, if future estimation work is conducted, and a different TDF is identified, it would have an effect on future claims.

[5] EUL is the date at which 50% of the measures have been removed or failed.

better than the non-energy efficient measures).[6] Those measures with calculated TDF ratios significantly less than 1.0 are measures for which claims can be affected by the TDF assumptions – if they are relatively commonly used in programs, and/or have large savings associated. Candidates included:

- Measure 3 (ratio=0.85)[7],
- Measure 16 (ratio=0.659), and
- Measure 19 (ratio=0.605).
- Measure 8 also shows a ratio lower than 1.0 (ratio=0.963).[8]

It was not possible to determine, *a priori*, whether changes to the TDFs for these measures would have a large effect on claims. The information that is filed with claims is largely at the program level, not the individual measure level. Whether or not a measure has a large impact on claims depends on whether the TDF value varies dramatically from 1.0, and whether the measure is responsible for a great deal of savings in programs – either because individually it produces a large amount of savings or because it is a common measure.

We issued a data request to the utilities, asking them to recompute earnings for Annual Earnings Assessment Proceedings, setting the TDFs for several measures with lower reliability to 1.0 rather than the Proctor values. The net claim impacts associated with past claims for two specific measures were computed:

- Measure 03 Oversized Evaporative-Cooled Condenser (ECC), and
- Measure 20 Agricultural Pump Repair or Replacement.

Table G1 below shows the impact for each utility and shareholder earnings claim year.

Table G1. Net Claims Impact from Substitution of TDF=1.0 for Measures 3 and 20 for Past Shareholder Earnings Claims (in dollars)

	Measure 03 (additions to submitted claim dollars are "+")	Measure 20 (deductions from submitted claim values are "-")	Total Net Claim Impact
PG&E Total	+$46,078	-$3,376	+$42,702
1995 3rd earnings claim (2000 AEAP)	+$5,763	-$1,746	+$4,017
1996 3rd earnings claim (2001 AEAP)	+$547	-$558	-$11
1997 3rd earnings claim (2002 AEAP)	+$39,768	-$1,072	+38,696
SCE Total	+$2,000	-$<1,000	+$1,000-2,000
1996 3rd earnings claim (2001 AEAP)	+$2,000	-$<1,000	+$1,000-2,000
SDG&E	+$0	-$198	-$198
1994 4th earnings claim	+$0	-$198	-$198
SCG	+$0	-$0	$0

Table G.1 shows that these measures did not have large impacts on AEAP claims, as recomputed by the utilities. The use of the Proctor TDF value led to lower claims on the order of $0 - $43,000 for each utility. Given that our assessment of the research addressing the TDF values was weaker than that for other measures, a case could be made that the associated claims could have been (minimally) higher for at least PG&E, and the potential level of adjustments to past claims would be very small.

6 See Measures 1, 2, 4, and 20 for examples.

7 The measure performance for the energy efficient equipment degrades faster than non-efficient equipment, and over the lifetime of the measure, only about 85% of the savings that might have been expected would be realized.

8 None of the measures were substantially higher than the 1.0 default value. The highest value was 1.04 for Measure 1.

Issues for Investigation in Future Earnings Claims

TDFs are an important issue, and an input to resource benefits and resulting claims computations. While the Proctor TDF study was an initial effort focused on an assessment of existing data, there are several measures that bear further investigation as inputs to future claims. In particular, additional analysis that includes primary data collection would be useful for:

- Those measures for which large savings are attributed by programs,
- Those measures for which the Proctor analysis indicates there may be significant chance for TDF not equal to 1.0 (particularly those less than 1.0), and
- Those measures with lower quality scores from our review of the Proctor analyses.

Candidates from the measures included in the Proctor study include:

- Measure 3 (ratio=0.85) received a low assessment score;
- Measure 16 (ratio=0.659), and bears review if it is associated with large savings;[9]
- Measure 19 (ratio=0.605), and bears review if it is associated with large savings;
- Measure 20 (ratio=1.004), received a low assessment score;
- Measure 24 (ratio=1.0), received a low assessment score;
- Measure 8 also shows a ratio lower than 1.0 (ratio=0.963), and bears review if it is associated with large savings.[10]

An important component of this planning would be to compute and rank the claim dollars associated with current – and future – measures. Many of these measures will have been explored in the Proctor study; however, others may not have received attention. Those with significant potential in future claims should be considered for additional study – potentially including on-site data collection. Some of the Proctor measures are no longer used or relevant and should not be re-examined.

Specific results, caveats and considerations associated with the conclusions are presented in Section 1.6 of this Attachment G.

Conclusions and Implications

We believe the Technical Degradation Factor is an important research topic in the computation and verification of savings from measures installed under programs funded with public monies. It is important that the difference in technical degradation rates between high efficiency vs. standard equipment is accounted for in the computation of expected savings, and resulting claims, deriving from programs. Further[11], it is important that all the utilities use the same TDF factors.[12]

We applaud the utilities for addressing the research question of the whether it is appropriate to implicitly (or explicitly) assume that the TDF for all measures is 1.0. The TDF study indicates

[9] We believe that Measure 16 (adjustable speed drives applied to injection molding machines) may bear more study, although it is difficult to tell whether the TDF value for this measure, which dramatically deviates from 1.0, will have a significant impact on claim values because it depends on the savings associated with this specific measure.

[10] None of the measures were substantially higher than the 1.0 default value. The highest value was 1.04 for Measure 1.

[11] Barring some clear and defensible differences in TDFs associated with specific brands, models, makers, etc. used in programs at different utilities – differences that are documented in a defensible TDF study.

[12] We have received confirmation from PG&E, SCE and the Sempra Utilities that the Proctor values were used in their computations of earnings claims for the pre-1998 period.

that assumptions of 1.0 may be appropriate for 17 of the 25 measures undertaken in this research study. The study concludes that for four measures, TDF ratios greater than 1.0 were indicated, and for another four measures, TDF ratios less than 1.0 (and in several cases, figures quite a bit less than 1.0) were estimated. Our review concludes that ***given the limitations and parameters of the TDF study – that is, a study based on available / secondary data*** – the results are credible and defensible for most of the measures.

It is important that the TDF values used are reliable and credible. The results of this review of the TDF study bring us to make several recommendations:

- **Effect on Past Earnings Claims**: There are several measures for which our review indicates the results of the Proctor TDF study are not as reliable as other measures, and for which we are not comfortable asserting that the TDF has been determined to be a specific value that differs from the default assumption of 1.0. This includes Measure 3 and Measure 20. The CPUC should consider allowing adjustments to past earnings claims to allow use of 1.0 as the default TDF for these two measures. However, re-computations of the associated earnings shows that the net impact of substituting TDF values of 1.0 for these measures represents higher claim values totaling only a marginal amount -- approximately $40,000 for PG&E and virtually nothing for the other utilities. The shareholder claim years affected include 1994 4th year, and 1995, 1996, and 1997 3rd year claims, included in AEAPs 2000-2002.[13]

- **Continue to Use TDF Values Analyses in Future Program Applications and Protocols Computations**: The CPUC should retain and confirm the use of TDF figures in the Protocols. The information on TDF values – perhaps with the exception of Measures 3 and 20 – and their implications should be considered in design and analysis for future programs.

- **Conduct Additional TDF Analyses on Some Measures to Support Future Claims**: The results of this review indicate that, while the Proctor study was generally strong, the CPUC and the utilities should re-examine the TDFs for several measures for use in future claims computations. In particular, collection of primary data may strengthen estimates for several key measures. A first step would be to compute and rank the claim dollars associated with current – and future – measures. This information would also be useful in setting priorities for future TDF analysis work. Those measures that are no longer relevant to future programs may be excluded from further analysis; however, those representing significant shares of "next" claims from past programs may still be relevant. The measures that bear further investigation – including potentially fieldwork or on-site data collection,[14] include the following:
    - 1) Those measures with relatively lower TDF quality / assessment scores should be re-examined to provide a more reliable estimate of the TDF value that should be associated with Measures 3, 20, and 24. If possible, well-designed primary data collection would be valuable in these applications, if the measures are still relevant and are included in future claims.
    - 2) Given the fact that the TDF ratios are different from 1.0 and therefore have the potential to impact claims dollars, similar re-investigation of the TDFs with low

[13] Details on claim years affected are provided in Table G.1.
[14] However, of course, "past" or obsolete measures may not be suitable for on-site data collection.

ratios may be warranted[15]. Candidates include measures 3, 8, 16, and 19 in this study – oversized evaporative cooled condenser, interior HID, process adjustable speed drives applied to injection molding machines, and dimmable daylighting controls, respectively.

- 3) TDF values that deviate even slightly from 1.0 can be important for measures that are used in many programs, or those that generate significant savings.
- 4) Additional TDF studies should be conducted to identify whether TDF values of 1.0 are reasonable for the range of other measures that may be used frequently in programs but were not examined in the five documents examined in this Attachment.

- **Clarify Measure-Associated Dollars or Savings in Retention Analyses as Elements of Required Submittals**: Dollars or percentage savings associated with each specific measure studied should be clearly laid out in each retention study; this was not the case in all retention studies. In some cases, the fact that the measures represented more than 50% of savings was merely asserted. In addition, to the extent the information is not included in required documentation, clarifying and reporting the link between measures and AEAP claim dollars would also be a significant benefit to the review of claims as they relate to retention and TDF values.

1.2 Definition of the TDF Study

The Protocols request a two-part analysis in the consideration of measure and savings retention. In addition to simply estimating how long measures were likely to stay in place and operating[16], the Protocols explicitly addressed the separate, but important research issue of:

How will demand-side management (DSM) program savings be affected over time by changes in the technical performance of efficient measures compared to the technical performance of the standard measures they replace?

Without TDF estimates, the implicit assumption is that this factor or effect represents a 1.0 multiplier applied to the measure life / EUL estimates. That is, the implicit assumption represented by a TDF=1.0 is that the technical degradation rates for high efficiency and standard equipment – and thus the associated energy savings -- decay at the same rate, regardless of efficiency level. The Proctor TDF analysis provided a set of Technical Degradation Factors, with one "factor" listed for each year for each measure. These annual factors are applied to the first year's savings, which yields an estimate of the energy savings in years subsequent to the first year. As defined by CADMAC, the TDF is … "a scalar to account for time and use related change in the energy savings of a high efficiency measure or practice relative to a standard efficiency measure or practice". The TDF is the ratio of savings in subsequent years to savings in the first year. These estimates were presented in a table showing calculated factors over a 20 year period for each of the 25 measures.[17] The measures examined in the five-part TDF study included:

1. Residential air conditioners
2. Commercial air conditioners
3. Oversized evaporative cooler condensers

[15] There were no measures with very high TDF ratio values, see Table G.2.

[16] Measure life and measure retention studies are examined in detail in the remainder of the full report and appendices.

[17] Proctor Engineering Group, "Summary Report of Persistence Studies: Assessments of Technical Degradation Factors, Final Report", CADMAC Report #2030P, 2/23/99, page 1.

4. Residential refrigerators
5. Electronic ballasts
6. Electronic ballasts and T8 lamps
7. Optical reflectors
8. High intensity discharge fixtures
9. Occupancy sensors
10. High efficiency motors
11. Adjustable speed drives for HVAC fans
12. Infrared gas fryers
13. Residential ceiling insulation
14. LED exit signs
15. Process adjustable speed drives – pumps
16. Process adjustable speed drives – injection molding
17. Residential wall and floor insulation
18. Daylighting controls – stepped
19. Daylighting controls – dimmable
20. Agricultural pumps
21. Variable air volume HVAC systems
22. Energy management systems
23. Air compressors
24. Compressed air distribution systems
25. Compact fluorescent lamps

The measures – and the standard technologies to which they are compared -- are further defined in the Proctor Engineering Group Summary Report. Proctor's study did not involve collecting new data for most measures, but instead, used data gathered from an exhaustive search of existing information from published and unpublished sources. This information was synthesized into an engineering analysis of technical degradation rates, and in specific cases in which measures showed uncertainties, additional research was undertaken. Our assessment includes a review of these additional research studies.

1.3 Assessment Methodology and Approach

The following five documents were reviewed for this assessment of technical degradation factor (TDF) studies:

1. (PEG 1996 Persistence 1) Proctor Engineering Group, Energy Investment, Inc., Texas A&M University Energy Systems Laboratory, and VaCom Technologies. 4/24/1996. *Statewide Measure Performance Study, Final Report: An Assessment of Relative Technical Degradation Rates*. CADMAC Report #2023P, San Francisco, CA: Persistence Subcommittee, California DSM Measurement Advisory Committee.
2. (PEG 1998 Persistence 2) Peterson, G. and J. Proctor. 5/14/1998. *Statewide Measure Performance Study #2: An Assessment of Relative Technical Degradation Rates, Final Report*. CADMAC Report #2027P San Francisco, CA: Persistence Subcommittee, California DSM Measurement Advisory Committee.
3. (PEG 1999 Persistence 3A) Peterson, G. and J. Proctor. 2/25/1999. *Persistence 3A: An Assessment of Technical Degradation Factors for Commercial Air Conditioners and Energy Management Systems, Final Report*. San Francisco, CA: Persistence Subcommittee, California DSM Measurement Advisory Committee (CADMAC Report #2028P).

4. (PEG 1998 Neg-TDF Supplement) Peterson, G. and J. Proctor. 10/18/1998. *Negative Technical Degradation Factors Supplement to Persistence Studies, Final Report*. CADMAC Report #2031P San Francisco, CA: Persistence Subcommittee, California DSM Measurement Advisory Committee.
5. (PEG 1999 Persistence Summary) Proctor Engineering Group. 2/23/1999. *Summary Report of Persistence Studies: Assessments of Technical Degradation Factors, Final Report*. CADMAC Report #2030P San Francisco, CA: Persistence Subcommittee, California DSM Measurement Advisory Committee.

Document 5 above cited a sixth study that was to be published. It was intended to focus on compressed air measures. We were unable to locate this report in the CALMAC reports database and, therefore, did not include it in our review.

We began our review by reading through the original analysis for each measure in either Document 1 or 2 listed above. About half the measures were covered in Document 1 and the other half in Document 2. In most cases, no follow-up analysis was conducted. We also verified that the original analysis was consistent with the complete summary compilation presented in Document 5.

We then reviewed the follow-up analyses presented for two measures in Document 3. These measures were analyzed further because of uncertainties raised in the original studies and the potentially significant impacts of degradation. Next, a review of Document 4 was conducted. The measures included in this study were a subset of those that the analyses in Documents 1 or 2 showed were likely to exhibit negative relative technical degradation.[18] In the original studies, the technical degradation factor was set to 1.0 for these measures. Both Documents 3 and 4 were compared with the information presented in Document 5 to assess consistency.

The following steps were conducted to document our reviews:

- Describe the measure changes from the baseline to efficiency measure examined in the study
- List and describe the potential degradation measures that were analyzed in the study
- Describe the methodology(ies) used to analyze each degradation mechanism or degradation as a whole if individual mechanisms were not studied
- Provide a text description of our evaluation of the degradation analyses that were conducted
- Provide a numerical rating of the overall study(ies) for each measure

Our evaluations and ratings were based on the following criteria:

- **Adequacy of the explanation:** Was the degradation analysis described clearly? Was the progression of steps logical? Were sources of information adequately cited? Were inconsistencies explained?
- **Use of secondary sources**: Were credible and objective sources used? Was the information germane to the analysis? Was a thorough search of sources and information available at the time of the study conducted?
- **Soundness of the methodology:** Was the methodology for synthesizing and analyzing the available data and information appropriate? Was the engineering analysis sound and was it applied correctly? Were uncertainties identified? Were conservative assumptions applied?

[18] In Proctor's terminology, negative technical degradation refers to relative savings that are likely to increase over time

1.4 Analysis of Individual Reports and Measures

The bulk of the research for the Proctor TDF review is summarized in Table G.2. This table addresses the results of the review of each study for each of the review criteria discussed above. The findings are summarized in Section 1.5, and dollar implications are summarized in section 1.6.

The table summarizes our reviews of the information provided in the five-part Proctor TDF study. The first three columns correspond to the summary information presented in the first two "studies" (documents 1 and 2 in Section 1.3). The remaining five columns present our review information.

The fourth column describes the measure changes covered by the degradation study. The next column describes the types of degradation mechanisms that were mentioned in the study; the studies did not necessarily examine each mechanism in detail. The sixth column describes the methodologies employed in the study(ies) for each measure. If the measure was included in a follow-up study, the second method is mentioned if it differed from the original one. If methodologies differed for specific degradation mechanisms, they are described separately. The next column presents our comments and descriptive assessment of the analysis of each measure. If more than one study was done for a measure, this assessment reflects our review of all the section of the overall TDF study. The final column is an overall numerical rating of the quality of the degradation analysis and presentation. The scale ranges from 1 (inadequate) to 5 (excellent). No analysis received a rating of less than 3 and lower ratings typically resulted from gaps in the discussion within the study that made it difficult to assess the validity of the analysis.

Table G.2. Review and Analysis of TDF Study

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
1. Residential Central A/C, High Efficiency	Standard SEER A/C	Negative	Changes selected for inclusion were comprehensive. Selected based on characteristics of most common baseline and high-efficiency units and product specs. Changes examined included increased condenser face area, scroll compressor, increased evaporator face area and reduced fin spacing, and use of TXVs.	Mechanisms considered were comprehensive. **Heat exchanger fouling (evaporator and condenser coil):** design changes can change dust deposition **Compressor efficiency changes:** scroll compressor performance **Refrigerant metering device**: effects of mischargings can vary with metering device **Distribution system leakage**: interactions with component performance	Research identified no long-term system efficiency studies so analysis focused on system component degradation. **Heat exchanger fouling:** relied on basic principles related to reduced air flow, reduced heat transfer, etc., and small number of available research papers and reports. Document 4 calculated negative degradation using two industry studies. **Compressor efficiency degradation:** relied on very limited industry information and inherent product characteristics **Refrigerant metering device**: assessed TXV and charge interactions qualitatively **Distribution system leakage**: assessed qualitatively	**Heat exchanger fouling:** thorough use of existing information and solid analysis. Conversion of commercial unit results to residential units was not well explained. **Compressor efficiency degradation:** valid conclusions based on sound analysis and limited information **Refrigerant metering device**: reasonable conclusions based on available information; with TXVs more common since this study, targeted research could be useful **Distribution system leakage**: effects were not explained in any detail	5
2. Commercial A/C, Package DX	Standard Efficiency Unit	Very little Negative (Document 3 revised from "some possible" in Document 1)	Changes selected for inclusion were comprehensive. Selected based on characteristics of most common baseline and high-efficiency units and product specs. Changes examined included increased adding more rows to condenser and evaporator heat exchangers, face area, scroll compressor, increased evaporator face area and reduced fin spacing, and use of TXVs.	Mechanisms considered were comprehensive. **Heat exchanger fouling (evaporator and condenser coil):** increased rows may increase arrestance and make cleaning more difficult **Compressor efficiency changes:** scroll compressor performance in smaller units	Research identified no long-term system efficiency studies so analysis focused on system component degradation. **Heat exchanger fouling (evaporator and condenser coil):** no direct research cited in original study. Original assessment (Document 1) was based on qualitative assessment. Document 3 reported results from lab testing. **Compressor efficiency changes:** relied on very limited industry information and inherent product characteristics	**Heat exchanger fouling (evaporator and condenser coil):** reasonable and conservative conclusions, based on limited information supplemented with lab testing **Compressor efficiency changes:** valid conclusions based on limited information	5

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
3. Oversized Evaporative-Cooled Condenser (ECC)	Air-Cooled Condenser (ACC)	Much Possible	Measure change is clearly defined as conversion from ACC to oversized ECC for supermarket refrigeration system	Mechanisms discussed were limited to most likely ones. **Heat exchanger fouling:** ACCs experience dust buildup on fins like air conditioners and occasional corrosion; ECCs experience tube heat exchanger fouling from scaling and biological fouling	Study cited some industry sources and research, but sources were very limited **Heat exchanger fouling:** used one study of capacity v. scaling thickness to estimate scaling effect on ECC efficiency; other information was anecdotal	Search approach and quantity of sources were poorly explained and documented. Conclusions were not always well explained. Primary analysis was good given lack of secondary sources.	3
4. Refrigerator 10-30% Better than Standard	Standard Efficiency Refrigerator	None or Negative	Manufacturers identified most common changes as compressor and fan motor efficiencies. Compressor efficiencies are attributed to more copper windings in motor, changed valve configuration, and lower viscosity oil. Condenser coil and fuzzy logic controls identified as less common.	Mechanisms included ones associated with design changes and others that might interact with changes. **Compressor efficiency**: possible effects of more copper windings, increased inlet are and decreased dead space in piston, lower viscosity on compressor efficiency/reliability **Fan motor efficiency:** effects of common motor efficiency improvements **Condenser coil fouling:** increased coil area may increase arrestance **Fuzzy logic control degradation:** degradation of electronics **Insulation outgassing:** outgassing reduces R-value, which might interact with efficiency improvements **Door gasket leaking:** gasket deterioration might interact with efficiency improvements	Study examined fairly limited available studies and manufacturers' information. Little primarily analysis was done. **Compressor efficiency**: drew upon efficient motor assessment for this study, logical (but unreferenced) claims, manufacturer comments **Fan motor efficiency:** drew upon efficient motor assessment for this study **Condenser coil fouling:** cited studies that showed little efficiency increase from coil cleaning **Fuzzy logic control degradation:** argues that solid-state devices are unlikely to degrade **Insulation outgassing:** cites studies showing insulation effectiveness degrades and modeled effect on high-efficiency refrigerators **Door gasket leaking:** used model showing effects of gasket deterioration could be large and contrasted with field-test literature showing little effect	**Compressor efficiency**: motor analysis was sound, but arguments about valve configuration were not well supported **Fan motor efficiency:** motor analysis was sound **Condenser coil fouling:** cited studies were acceptable, but assessment did not address effects of larger coil areas **Fuzzy logic control degradation:** no supporting evidence was provided, but this technology was not very common. **Insulation outgassing:** cited studies were credible; modeling was described some in Document 4 study **Door gasket leaking:** conclusion about little effect of gasket leaking might be tenuous because it appeared to be based on a single study that did not distinguish units with leaky gaskets from those without; study provided reasonable evidence that there might be no relative effect for efficient units	4

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
5. Electronic Ballast	Efficient Magnetic Ballast	None	Measure is conversion from coil transformer plus capacitor to solid-state device. No individual components were assessed.	A few specific degradation mechanisms were mentioned, but none were discussed in detail. Effect of operating temperature changes over time was discussed.	Study indicates that at the time no empirical performance data were available. Study relied primarily on manufacturer and researcher interviews.	Study did an adequate job of using very limited research and interview data to draw conclusions. More supporting evidence should have been provided about how operating temperature changes over time affect relative performance.	4
6. T8 with Electronic Ballast	T12 with Efficient Magnetic Ballast	None	Measure was conversion from coil transformer plus capacitor to solid-state device (see above) and use of T8 lamp instead of T12. T8 has smaller diameter and improved phosphors in some cases. T8 performance and interactions with ballast were addressed.	Specific degradation mechanisms were not examined. Indications of degradation such as changes in light output and power draw over time were considered.	Reasonable statements about performance were made, but sources were not cited. Logical extensions of this information were made.	A reasonable case was made for conclusions based on acceptable engineering arguments, but no citations of sources were provided.	4
7. Optical Reflector, Delamp	Standard Fixture	Energy – None Light Output - Some	Changes were installing reflector, cleaning lens, removing two tubes and one ballast. Advisory committee directed assessment at illumination degradation primarily.	Reduced lamp temperature from delamping increased power draw. Considered lighting degradation from reflector material degradation, delamping, cleaning, and lamp changes.	Used results from ballast analysis (above) to assess temperature effects on energy. Referenced limited studies of reflector abrasion and dirt degradation on lighting. Presented logical arguments about delamping, cleaning, and lamp change effects on lighting.	Temperature effect analysis was consistent with analysis for ballasts. Assessment of light degradation was reasonable given lack of prior analysis.	4
8. HID Interior Metal Halide 250-400W	Mercury Vapor 400-1,000W	Very Little	Ballasts differ and HID vapor contains metal halides	**Ballasts:** ballast losses could vary with ballast design and lamp arc voltage. **Arc voltage:** arc voltage could change with vapor changes, electrode erosion, and operating temperature changes. **Light output** would depend on current crest factor.	**Ballasts:** examined ballast designs and found no significant differences between HID and mercury vapor. **Arc voltage:** contacted industry sources regarding arc voltage and power draw and obtained test and analyzed. **Light output:** relied on manufacturer and expert interviews for light output degradation information.	Analysis was thorough in all areas given extent of available data and information.	5

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
9. Occupancy Sensors	On/Off Switches	Some Possible, Retention Issues	Use of ultrasonic or infra-red sensors in place of on/off switches	Sensor operation would depend on sensitivity and time delays. Infra-red and ultrasonic sensors could give false positive signals leading to excessive lighting or false negative occupancy signals leading to occupants overriding. Dust accumulation could decrease sensitivity. Sensor components can degrade.	No information directly on degradation was located. No sensor component degradation information was available, but manufacturers provided claims that none occurred. Analysis provided logical argument that sensitivity changes due to dust could cause overriding of sensors.	Assessment was reasonable given limited information available. Study properly suggested that this was an issue for retention studies.	5
10. Motor – High Efficiency	Standard Efficiency Motor	None	Mechanical and design changes including use of high-grade steel in core, thinner material and improved insulation, longer cores, improved slot designs, and larger rotor bars to reduce four types of losses	Effects of design/material changes, possibly higher operating temperatures, and problems unique to rewound motors	Examined design and material changes and reviewed study in the literature. Obtained information from researchers and manufacturers and reviewed available studies.	Thorough review of changes in high-efficiency motors and information sources and reasonable conclusions.	5
11. Adjustable Speed Drive for HVAC Fan	Variable Inlet Vanes or Dampers	None, Retention Issues	Fan motor flow control with variable inlet vanes or discharge dampers in baseline system replaced with pulse-width modulating adjustable speed drive	For baseline system, poor response of mechanical devices. For ASD system, degradation of electronic components, sensor drift or improper adjustment, and interactions between ASD operation and motors.	Relied on contacts with manufacturers and independent researchers and limited available literature. Researchers and manufacturers identified potential ASD degradation factors, but said most were minimal. Study argued that sensor degradation could be significant factor, but little information was located. Identified interactions between ASDs and motors as uncertainty, but little information was located.	Research was thorough, but little published data or information were available. Study did not indicate how many manufacturers or researchers were contacted. It seems more information could have been obtained on sensor performance.	4

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
12. Infra-red Gas Fryer	Standard Atmospheric Fryer	Unlikely	Use of power burner instead of atmospheric; burner located externally; intermittent ignition device instead of pilot light	**Burner design:** fouling of standard burner heat exchangers and clogging of air flow in infra-red burners **Heat exchanger/vat design:** fouling of heat transfer surfaces **Ignition device:** considered to be reliability issue instead of savings degradation	No literature, data, or even standard test procedures were available **Burner design:** relied on discussions with manufacturers and experience from space heating systems. Analyzed possible magnitude of air flow clogging effects for infra-red fryers. No empirical data were located. **Heat exchanger/vat design:** assessed designs and potential for fouling	Analysis was thorough in identification of possible degradation mechanisms and use of very limited available data and information.	5
13. Residential Ceiling Insulation	Standard Levels Attic Insulation	None	Addition of ceiling insulation in existing home to bring level to R-30 or increase beyond code in new home to bring to R-38	Potential mechanisms included insulation removal, compression, disturbance, or damage. Focused on human-caused mechanisms.	Contacted contractors and weatherization providers for estimates of frequency and extent of most common degradation mechanisms. Used estimates to develop worst case and calculated net effect on heat transfer. Compared findings with weatherization study results.	Appropriately used industry sources for input data and applied heat transfer analysis adequately. Did not provide justification for not addressing settling of blown insulation over existing insulation, but this may not have any notable effect.	4
14. LED Exit Signs	Incandescent Exit Signs	None, Retention Issue	Conversion from 40W incandescent lighting to 4W LED	**Energy:** Excitation current and external control for LEDs. Filament wear for incandescents. **Light output:** Type, excitation, temperature, and humidity for LEDs. Filament wear for incandescents.	**Energy:** Available research studies for LEDs. Curves relating wattage to time for incandescents. **Light output:** Numerous studies and manufacturer claims for LEDs. Curves relating output to time for incandescents	Analysis was reasonable based on available data and studies.	5
15. Process Adjustable Speed Drives, Waste Water Pumps	Inlet Vane Throttling on Waste Water Pumps	None	Waste water treatment plant pump flow control with baseline inlet throttling replaced by pulse-width modulating adjustable speed drive control in efficient system	For baseline system, no specific mechanisms defined. For ASD system, see Measure 11 plus reduced pump wear.	See Measure 11. Information from Measure 11 supplemented by additional contacts and literature search. Expanded information on ASD/motor interactions. Document 4 argued that replacement of pump in baseline and efficient cases would net out wear effects.	Research was thorough and additional sources were cited.	5

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
16. Process Adjustable Speed Drives, Injection Molding Machines	Standard Injection Molding Machines	Much Possible	Injection mold with baseline continuous operation pump with bypass control converted to similar system with ASD to control pumping in efficient system	For baseline system, no specific mechanisms defined. For ASD system, see Measure 11 plus operator interactions.	See Measure 11. Information from Measure 11 supplemented by multi-site study in literature.	Research was thorough and additional sources were cited.	5
17. Fiberglass Batt R-15 Wall and R-19 Floor Insulation	R-13 Fiberglass Batt Wall and Floor Insulation	None	Increased batt insulation levels from R-13 to R-15 in wall and R-19 in floor in new residential construction	See Measure 13 plus sagging of floor insulation	See Measure 13.	Appropriately used industry sources for input data and applied heat transfer analysis adequately. Did not discuss relative degradation.	4
18. Daylighting Controls - Stepped	Standard Manual Lighting Controls	None	Baseline on/off switches replaced with photosensors and stepped controls for blocks of lights	**Photosensor failure**: reversion to full-on **Controls bypass:** occupants might bypass or disable controls **Photosensor error:** dust could cause drift **Window coverings:** use of window coverings could affect sensor operation	**Photosensor failure**: logical argument about effects of failure **Controls bypass:** references to literature **Photosensor error:** logical arguments based on limited literature **Window coverings:** literature and logical arguments	**Photosensor failure**: argument was reasonable, but no sources were cited **Controls bypass:** sources for some assertions were not provided, but argument was sound **Photosensor error:** cited literature was quite limited **Window coverings:** several studies were cited and argument about capturing effect in first-year savings was reasonable	5

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
19. Daylighting Controls – Dimmable	Standard Manual Lighting Controls	Much Possible	Baseline on/off switches and fluorescent lights replaced with photosensors, dimmable fluorescent systems, and dimming controls in efficient system	**Photosensor failure:** reversion to full-on and higher power draw of dimmable ballasts **Decreased light output**: dust and wear would reduce output and system would increase illumination to compensate **Ballast failure:** failure in full-on mode would increase power draw **Controls bypass:** occupants might bypass or disable controls **Photosensor error:** dust could cause drift **Window coverings:** use of window coverings could affect sensor operation **Lack of commissioning:** non-commissioned systems could fail to operate properly, leading to bypassing	**Photosensor failure:** logical argument about effects of failure **Decreased light output**: references to available studies plus limited analysis **Ballast failure:** relied on manufacturer information and available studies **Controls bypass:** references to literature **Photosensor error:** logical arguments based on limited literature **Window coverings:** literature and logical arguments **Lack of commissioning:** reference to several studies	**Photosensor failure:** argument was reasonable, but no sources were cited **Decreased light output**: reasonable conclusions based on several sources **Ballast failure:** relied on manufacturer information and available studies **Controls bypass:** sources for some assertions were not provided, but argument was sound **Photosensor error:** cited literature was quite limited **Window coverings:** several studies were cited and argument about capturing effect in first-year savings was reasonable **Lack of commissioning:** cited literature solidly supports findings	5
20. Agricultural Pump Repair or Replacement	Existing Agricultural Pump	Very Little Negative (values estimated in Document 4)	Retrofit of new impeller and bowl assembly to an existing vertical turbine agricultural pump	Bowl and impeller wear due to particle abrasion, cavitation, and vibration	Expert contacts, literature search, review of pump wear research, analysis of utility pump testing data. Final results were drawn primarily from analysis of pump testing data. Document 4 estimated negative degradation factors.	Study presented thorough review of degradation mechanisms. Conclusions were based on pump test data, but data for individual pumps did not clearly support conclusions. More information would be needed to confirm validity of assessment.	3
21. Variable Air Volume HVAC Distribution System	Constant Air Volume HVAC Distribution System	Uncertain	Installation of VAV system in new commercial building instead of baseline CAV system	**System complexity and interactions:** more complex systems would be likely to suffer more degradation **Temperature sensor error:** temperature reading errors would be likely to increase over time and errors increase energy usage	**System complexity and interactions:** relied on extensive literature and field experience **Temperature sensor error:** used results from two published studies	Analysis made good use of available studies. Conclusion that effects roughly cancel each other was reasonable given available information.	5

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
22. Energy Management Systems	Manual Operation	None	Computer-based control system for HVAC equipment in place of baseline standard manual and on/off controls	Wide range of possible mechanisms discussed, but analyses focused on aggregate results	Original study (Document 2) relied on review of several existing reports. Second study (Document 3) analyzed billing data from 40 installations using several regression models.	Original analysis relied on secondary studies and showed significant degradation. However, these studies had several weaknesses, which were pointed out in second analysis. Second analysis was very thorough, addressed possible biases, and adequately explained differences in results from original study. It used data from retrofit buildings only, however, and suggested that degradation in new buildings might differ, though this is not explored further.	5
23. New Air Compressors	Existing Air Compressors	Compressors: None System: Much Possible**	Replacement of baseline existing lubricant-flooded rotary screw compressor with new, same type of compressor with various efficiency enhancements	Numerous design and material changes that increase efficiency were examined. Three possible degradation mechanisms were identified. **Bearing degradation:** bearing wear could cause other components to wear **Other component wear** **System degradation:** changes in compressor output could increase leaks	Original study used manufacturer information, studies, and logical arguments.**	Conclusions about compressor degradation were reasonable based on material and design changes. System degradation claimed in original study was asserted without supporting information.**	4**
24. High Efficiency Compressed Air Distribution System	Standard Efficiency Compressed Air Distribution System	Much Possible**	Baseline system was assumed to be leaky, sized poorly, clogged, and with improperly set regulators. Replacement system would have an expander to control pressure in a storage tank, minimized leaks, appropriate sizing, and appropriate settings.	**Decline in effects of user training:** efficient operation would require correct operation and maintenance and education effects might not last **Equipment degradation:** savings could degrade if performance of new equipment declined **Leaks:** leaks could grow over time	Original study used manufacturer information, studies, and logical arguments.**	Conclusions about O&M and equipment were reasonable. Reasons why leaks would have larger relative effects in efficient system were not clearly explained.**	3**

Efficiency Measure	Baseline Technology	Relative Degradation Assigned	Degradation Analysis Assessment				
			Measure Changes Addressed	Degradation Mechanisms Considered	Methodologies	Evaluation of Degradation Analysis	Overall Rating*
25. 13 W Hard-wired Compact Fluorescent Downlights	Incandescent Downlights	None	Replace baseline 100 W incandescent in down-lighting and wall sconces with 2, 13 W hard-wired CFLs	**Deterioration of CFL components, dust accumulation, etc.:** effects could reduce efficiency **Temperature effects:** CFL ballast losses and dust deposition over time could increase lamp temperature **CFL ballast degradation:** various mechanisms could increase power draw **Incandescent degradation:** filament wear would reduce light output and decrease power use	All degradation analyses relied on contacts with manufacturers and researchers and reviews of available studies and literature	Analysis was reasonable	5

*Scale ranges from 1 (inadequate) to 5 (excellent).

** Significantly different results are reported in Document 5 summary report, but the study cited in that report was unavailable for review so our assessment does not address this study or its findings.

1.5 Findings and Considerations on Quality of the Proctor TDF Study

Overall, this body of studies provides a technically sound basis for estimating relative technical degradation factors for a wide range of efficiency measures. The review team notes that a study based on primary research with data collected using a research design and data collection / sampling approach that would specifically address TDF issues would provide the strongest analysis of TDFs. However, the budget, timeline, and scope of the Proctor TDF study did not include primary data collection except in a few areas that supplemented the original documents. Given the *a priori* constraints of the study's scope, our review concludes that the work represents a valuable addition to the literature on a topic that has been under-addressed relative to retention work, and that the work was solid. However, the work also highlights the fact that some measures would be well-served with additional research and primary data collection.

- **Thorough Analysis**: We found that the analyses of most measures were thorough where the available secondary data and information permitted. In several cases where degradation could be linked to specific components of efficient and baseline measures, the Proctor TDF study and its elements explored the details of the components and potential degradation mechanisms. In general, original analyses that were conducted based on the existing information were technically competent. In several cases where further analysis was recommended, follow-up analyses were conducted. At first, Proctor was requested to record the technical degradation factor as 1.0 for measures that exhibited likely increases in relative energy savings over time; later, the authors conducted follow-up analyses to quantify such negative relative technical degradation factors for four measures.[19]

- **Lack of Available Data**: In some cases, the analyses suffered from a lack of available data and information. It was not possible to conduct primary research or testing on most measures, so the availability of relevant data in the literature or from sources was critical. Although there was often a considerable amount of information available on most measures, it was often not focused on how energy efficiency might degrade over time. The authors did an excellent job of extracting information from these sources that could be used to make inferences about efficiency degradation, but in many cases the available information was inadequate to draw solid conclusions about relative energy-efficiency performance.

- **Documentation on Sources**: One generic concern about the Proctor TDF study was the lack of adequate documentation on sources. Most of the analyses referred to information provided by manufacturers and experts. However, the individual studies rarely indicated what type or how many sources provided the information. Consequently, it was difficult to make an informed judgment about the quality, quantity, and objectivity of the information relied upon.[20]

[19] By definition in the Proctor study, negative factors have a value greater than 1.0.

[20] In some cases, information was obtained from combinations of manufacturers, independent researchers, and knowledgeable third parties. It might be argued that manufacturers have incentives to misrepresent the performance of their equipment. However, the Proctor analysts did not rely on manufacturer sources alone. In addition, we note that the rationales and analyses that followed from the information were carefully explained in the TDF study and conformed to solid practices. However, in a few cases, the number of secondary sources was not provided. In cases where there was concern the information might be from a very small sample, or it was unclear whether the sources might be disproportionately from "interested" sources, the study received a lower score.

- **Information Gaps**: We had a few other, but less significant, concerns. In a few cases there were some gaps in the information presented in the study. These gaps made it difficult to follow the arguments being made and assess the validity of the conclusions that were drawn. In the second study listed above, the presentation on daylighting control measures combined stepped and dimmable systems, but in the summary report (report 5 in list above) the two measures were presented separately. As a result, 25 measures are shown in the summary report, but only 24 are shown in the two initial reports. Finally, the text for Measure 15 in the summary report (Process adjustable speed drives – pumps) does not indicate that it was included in the negative degradation report (fourth report in list above).

1.6 Measures with Lower Reliability TDF Values

There were several specific measures for which the TDF analysis was given a lower score, indicating more work would be needed to provide confidence in the results. There are three measures for which the analysis received a score of 3.0, which we believe implies that the measures need further investigation before a specific TDF different from a default of 1.0 can be assigned for the purposes of earnings claims.

Measures with a score of 3.0 include:

- **Measure 3 – Oversized Evaporative Cooler Condenser (ECC):** This measure, with a potential lifetime of 20 years, showed a relative ratio between the Proctor and default (1.0) TDF of 0.85 over the estimated useful life of the measure, compared to the degradation associated with a standard efficiency measure (see Table G.3). This indicates that the high efficiency measure's savings degrade at a faster (higher) rate than standard condensers.
    - ***Implication for shareholder earnings claims**: If the CPUC determines that the TDF estimate for this measure is not sufficiently reliable, then the utility claims associated with that measure were lower than appropriate. Earnings claims for this specific measure (and potentially "like" measures) were re-computed by the utilities. The overall impact on AEAP claims were: $46,078 for PG&E; $2,000 for SCE, and $0 for the other utilities. If the CPUC determines that, until proven otherwise, the TDF to be used is 1.0, which implies the claims for savings associated with this measure could have been (marginally) higher. These figures affect 1995, 1996, and 1997 3rd earnings claims for PG&E, and 1996 3rd earnings claim for SCE. See Table G.1 for details.*
- **Measure 20 – Agricultural Pump Repair or Replacement**: This measure, with a potential lifetime of approximately 9 years, showed a relative TDF ratio of 1.004 over the life of the measure, compared to the degradation associated with a standard efficiency measure. This indicates that the high efficiency measure's savings degrade at a slower rate than standard pump repair or replacement activities.
    - ***Implication for earnings claims**: If the CPUC determines that the TDF estimate for this measure is not sufficiently reliable, then the utility claims associated with that measure were slightly higher than appropriate. Earnings claims for this specific measure (and potentially "like" measures) were re-computed by the utilities. The results showed very small impacts – $3,376 for PG&E, less than $1,000 for SCE, less than $200 for SDG&E, and $0 impact for SCG. Given the small TDF impact, and the minimal dollar impacts, no change is needed at this time, as claim dollars are not affected by the Proctor TDF value. These figures affect 1995, 1996, and 1997 3rd earnings claims for PG&E, 1994*

4th earnings claim for SDG&E, and 1996 3rd earnings claim for SCE, See Table G.1 for details.

- **Measure 24 – High Efficiency Compressed Air Distribution System**: This measure, with a potential lifetime of approximately 12 years, showed a relative TDF of 1.0, equal to the default value. Therefore, there are no earnings implications deriving from the lower reliability of the TDF associated with this measure.

1.7 Claim-Related Implications of the Assessment of Proctor TDF Study

Table G.3 summarizes the results of the review of the TDF values analyzed in the 5-part report. The columns in the table provide the following items for each of the 25 measures reviewed in these studies:

- Columns A&B: Measure and baseline technology
- Column C: Score for the assessment of the quality of the TDF study (1-5 scale, 5=high)
- Column D: EUL – Accepted measure lifetime from the California Protocols, Appendix F "Effective Useful Life Values for Major Energy Efficiency Measures", from the www.Calmac.org web site.
- Column E: Relative TDF Degradation assigned by the Proctor study, from Table G.2.
- Column F: TDF Multiplier, computed as the sum of the TDF factors from Table 3-1 of the Proctor Summary Report, summed from Year 1 to the year of the *ex ante* EUL or measure lifetime.
- Column G: Calculated TDF ratio, computed as the TDF savings over the lifetime, divided by the savings if the TDF were assumed to be 1.0 (the default) over the lifetime.
- Column H: For two measures for which we asked about dollar impacts from the utilities, we provide the estimated net impact across the AEAP claims as provided by the utilities. The impact is estimated as the difference between using the Proctor value for the TDF vs. using a TDF value of 1.0.

The total of the dollar implications of the variations from an assumption of TDF=1.0 is provided in the last row of Table G.3. A positive number implies that the estimated TDF means more savings would be realized than if a TDF=1.0 was assumed; a negative number means fewer savings are realized than with a 1.0 TDF.

A computation of the impact of excluding the Proctor values for TDFs for Measure 3 and Measure 20 (those with lower reliability scores), and instead assuming a TDF of 1.0 for each was derived by the utilities in response to a data request. We find that if TDFs of 1.0 are used as a default for these measures, the total impact on past claims would be that the pre-1998[21] claim across all the utilities would be approximately $40K higher, virtually all reflected in PG&E's revised computation.

In addition, to facilitate future analyses of retention, persistence, and TDF studies in the future, we recommend the CPUC consider asking the utilities to estimate the percent of savings and/or claim dollars associated with the variety of specific measures (or groups of measures) as part of future submittals. This would also assist in setting priorities for future TDF research.

Additional recommendations and conclusions are presented in the Executive Summary portion of this Attachment.

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[21] These figures affect 1995, 1996, and 1997 3rd earnings claims for PG&E, 1994 4th earnings claim for SDG&E, and 1996 3rd earnings claim for SCE. The detail on these claim years is provided in Table G.1.

Table G.3. Potential Dollars at Risk for Measures

A. Efficiency Measure	B. Baseline Technology	C. Assess-ment Score	D. Lifetime (CPUC Protocols) [22]	E. Relative Degradation Assigned	F. TDF Multiplier Factor from Studies (sum through year associated with lifetime)	G. Calculated TDF Ratio Col F/(1*ColD)	I. Potential Claim Dollars[23] affected (computed by utilities)
1. Residential Central A/C, High Efficiency	Standard SEER A/C	5	18	Very Little Negative	18.76	1.042	
2. Commercial A/C, Package DX	Standard Efficiency Unit	5	15	Some Possible	15.24	1.016	
3. Oversized Evaporative-Cooled Condenser (ECC)	Air-Cooled Condenser (ACC)	3	20	Much Possible	17.0	0.85	PG&E: +$46,078; SCE: +$2,000
4. Refrigerator 10-30% Better than Standard	Standard Efficiency Refrigerator	4	18	None or Negative	19.49	1.083	
5. Electronic Ballast	Efficient Magnetic Ballast	4	16	None	16.0	1.0	
6. T8 with Electronic Ballast	T12 with Efficient Magnetic Ballast	4	16	None	16.0	1.0	
7. Optical Reflector, Delamp	Standard Fixture	4	10(-12?)	Energy – None Light Output - Some	10.0	1.0	
8. HID Interior Metal Halide 250-400W	Mercury Vapor 400-1,000W	5	16	Very Little	15.4	0.963	
9. Occupancy Sensors	On/Off Switches	5	8	Some Possible, Retention Issues	8.0	1.0	
10. Motor – High Efficiency	Standard Efficiency Motor	5	15(-20?)	None	15.0	1.0	
11. Adjustable Speed Drive for HVAC Fan	Variable Inlet Vanes or Dampers	4	16(?)	None, Retention Issues	16.0	1.0	
12. Infra-red Gas Fryer	Standard Atmospheric Fryer	5	8(?)	Unlikely	8.0	1.0	
13. Residential Ceiling Insulation	Standard Levels Attic Insulation	4	25	None	25.0	1.0	
14. LED Exit Signs	Incandescent Exit Signs	5	16	None, Retention Issue	16.0	1.0	
15. Process Adjustable Speed Drives, Waste Water Pumps	Inlet Vane Throttling on Waste Water Pumps	5	9(-10?)	None	9.0	1.0	
16. Process Adjustable Speed Drives, Injection Molding Machines	Standard Injection Molding Machines	5	10(-20?)	Much Possible	6.59	0.659	
17. Fiberglass Batt R-15 Wall and R-19 Floor Insulation	R-13 Fiberglass Batt Wall and Floor Insulation	4	8	None	8.0	1.0	
18. Daylighting Controls – Stepped	Standard Manual Lighting Controls	5	8(-16?)	None	8.0	1.0	
19. Daylighting Controls – Dimmable	Standard Manual Lighting Controls	5	8(-16?)	Much Possible	4.84	0.605	
20. Agricultural Pump Repair or Replacement	Existing Agricultural Pump	3	9(?)	Very little Negative (values estimated in Document 4)	9.04	1.004	PG&E: -$3,376 SCE: -$<1,000; SDG&E: -$<200

[22] (?) indicates the precise measure was not listed in the protocols; we assigned an EUL from a similar measure. Also, if there was a high and low figure, we selected the lower lifetime to be conservative on the impact.

[23] These estimates were computed by the utilities in response to a data request by SERA. The claim years affected are listed in Table G.1.

A. Efficiency Measure	B. Baseline Technology	C. Assess-ment Score	D. Lifetime (CPUC Protocols) [22]	E. Relative Degradation Assigned	F. TDF Multiplier Factor from Studies (sum through year associated with lifetime)	G. Calculated TDF Ratio Col F/(1*ColD)	I. Potential Claim Dollars[23] affected (computed by utilities)
21. Variable Air Volume HVAC Distribution System	Constant Air Volume HVAC Distribution System	5	16(-20?)	Uncertain	16.0	1.0	
22. Energy Management Systems	Manual Operation	5	10(?)	None	10.0	1.0	
23. New Air Compressors	Existing Air Compressors	4	12(?)	Compressors: None System: Much Possible**	12.0	1.0	
24. High Efficiency Compressed Air Distribution System	Standard Efficiency Compressed Air Distribution System	3	12(?)	Much Possible**	12.0	1.0	
25. 13 W Hard-wired Compact Fluorescent Downlights	Incandescent Downlights	5	16	None	16.0	1.0	
Total							PG&E: +$42,702 SCE: +$1,000-2,000 SDG&E: -$200